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THE PROPOSED SOUTHAMPTON STREET REFUSE INCINERATOR, BOSTON, MASSACHUSETTS

BY GEORGE W. COFFIN, Member*

(Presented at a meeting of the Sanitary Section, B.S.C.E., held on March 6, 1946.)

INTRODUCTORY

The Problem

The design of an incinerator is not a detached engineering problem. Before beginning the design of a municipal refuse incinerator, many factors must be considered. The amount and character of the refuse to be delivered to the incinerator must be determined, and the degree to which combustible refuse can, as a practical matter, be separated from non-combustible refuse. If, as in the case of the proposed Boston incinerator, the heat from the burning refuse is to be used to generate steam for commercial purposes or for use outside the plant, the problem of collection and separation of the different types of refuse becomes even more important.

The problem of the disposal of municipal refuse by incineration has long been a subject of serious study by Public Works Officials and Engineers, and with the interest now being shown in this subject, it is hoped that our cities and towns will become cleaner and healthier places in which to live by the adoption of this rational and sanitary method.

Analogy to the Problem of Sewage Disposal

The development of a rational and scientific method of refuse

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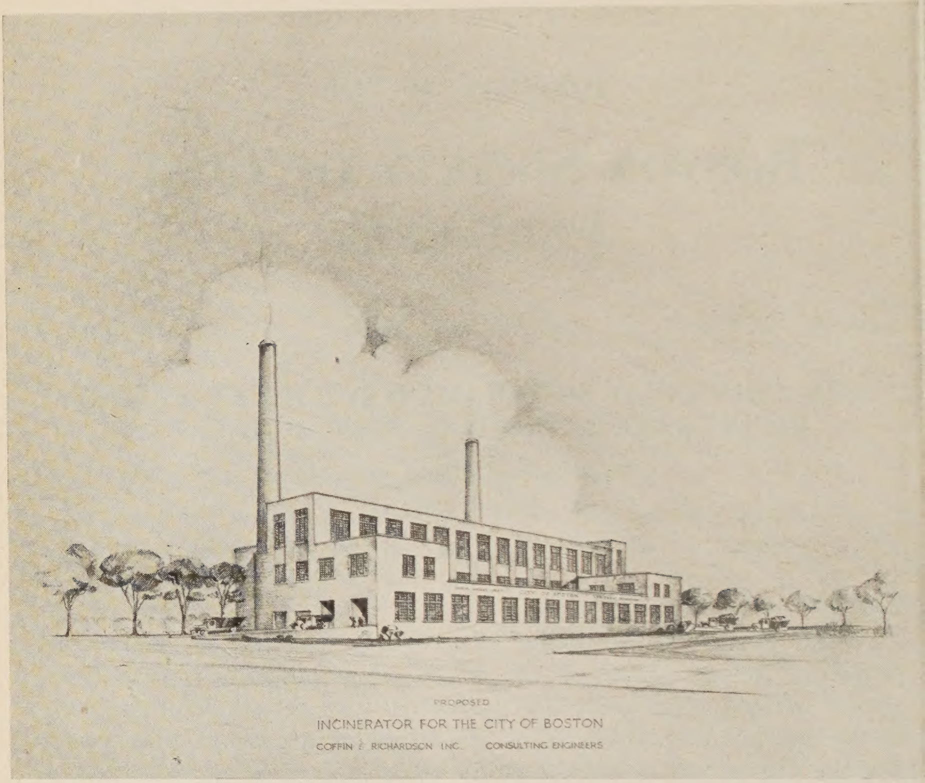
PROPOSED
INCINERATOR FOR THE CITY OF BOSTON
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disposal is analogous to the development of our modern sewage treatment plants. It has been the practice in the past, and still is even in many of the larger municipalities, to dispose of sewage by discharging it with little or no treatment into the nearest stream or other body of water, and then forget it. This method of sewage disposal is no longer acceptable to communities now awakened to the value of their streams and ocean beaches.

The disposal of municipal refuse has followed the same pattern as the disposal of sewage, that is, the refuse has been trucked or shipped to the handiest apparently undesirable area and there left to rot and decay generally assisted by partial burning with the attendant familiar odor and smoke pall.

The objections to rat and vermin infested open dumps with haphazard burning, are too obvious for further comment and no enlightened community will much longer tolerate this antiquated method of disposal.

Description and Character of Municipal Refuse

In order to understand the basic principals of the design of an incinerator, a knowledge of the different types of municipal refuse is necessary.

In general, municipal refuse may be divided into seven classes as follows:

1. Household refuse (old papers, cartons, tin cans, bottles and miscellaneous rubbish).
2. Garbage
3. Ashes
4. Commercial refuse (from stores, offices and retail establishments).
5. Street sweepings.
6. Catch basin deposits.
7. Mixed refuse (refuse containing a mixture of any or all of the above).

In general, municipal refuse is a low grade fuel, whose heat value, moisture content and density varies over wide ranges and in our larger cities it is a mixture of everything from automobile fenders, feather beds, coils of wire, large and small miscellany, and in fact, anything that can be loaded into a truck and delivered to the disposal plant. This latter material is commonly known as "rough stuff".

Most of the refuse with which the designer of an incinerator is concerned comes from our homes, stores, offices and street sweeping patrols. The term "Mixed Refuse" is used to denote a mixture of garbage, rubbish and ashes as collected. In this paper the term "refuse" is used to mean whatever material is taken to the incinerator for disposal and may indicate separately collected garbage, mixed refuse, commercial refuse and street sweepings.

Collection and Disposal

The methods of collection and disposal of the above types of refuse are many and varied. It is common practice in many communities to dispose of garbage by shipping it to hog farms, a practice, however, which is condemned by the U. S. Public Health Service, and other health authorities. In some communities garbage is disposed of by rendering plants. In others it is mixed with household refuse and incinerated. Commercial refuse and street sweepings are generally collected separately, although usually disposed of with other municipal refuse. Ashes in bulk and catch basins deposits are generally collected separately and disposed of as solid fill.

Collection of household refuse, garbage and ashes as mixed refuse is common practice in many cities. For a complete discussion of the problem of collection of municipal refuse reference is made to "Refuse Collection Practice" published by the American Public Works Association, Chicago, Illinois.

The Sanitary land fill method of disposal for mixed refuse and controlled burning in the open of combustible refuse only, has found favor in some cities. Although these methods have certain advantages in some cases where ample areas are available, their general use is limited and they are open to many of the same objections as the common dump.

Incineration

The adoption of incineration in high temperature fast burning furnaces has become recognized as the cleanest, quickest and most sanitary method of refuse disposal. With properly designed furnaces and an efficient incinerator operating schedule, no smoke, odor, fly ash or other nuisance will result from this method of disposal.

Complete separation of combustible from non-combustible refuse is the desideratum for successful incineration. The better the separation, the more efficient the incineration. This is an ideal, however, and practical considerations must govern the design of an incinerator. Separation of combustible and non-combustible refuse is of primary importance if the waste heat from the burning refuse is to be used for the generation of steam.

If it is desired to burn garbage in an incinerator, sufficient combustible refuse must be collected to provide fuel to evaporate the moisture in the garbage. For best results, garbage should be thoroughly drained and wrapped in paper before depositing it in receptacles for collection. Small tin can food containers, although they have no fuel value are best collected with combustible refuse and allowed to pass through the incinerator as this cleanses the cans and their ultimate disposal does not present a sanitary hazard.

Bottles and glassware should be kept out of incinerator furnaces as molten glass forms a slag with the ashes and makes the cleaning and operation of the grates, particularly if any form of moving grates are used, much more difficult and expensive.

QUANTITY OF REFUSE PRODUCED IN AMERICAN CITIES COMPARED WITH BOSTON

The quantity and density of refuse produced varies widely in different cities. Tables 1 and 2 indicate the range in several typical groups of cities. The data in these tables for cities other than Boston is from "Refuse Collection Practice" published by the American Public Works Association to which reference is made for further data.

TABLE 1.—QUANTITY OF REFUSE PRODUCED IN AMERICAN CITIES COMPARED WITH BOSTON

	Pounds per capita per day (365 days per year)*			
	Min.	Max.	Average	Boston
Garbage only (48 cities)	.19	1.51	.65	.31
Garbage and combustible rubbish (38 cities)	.43	2.59	1.19	.91
All refuse collected together (16 cities)	1.61	4.32	2.17	2.50

TABLE 2.—DENSITY OF REFUSE IN AMERICAN CITIES COMPARED WITH BOSTON

	Pounds per Cu. Yd.				Cu. Yd. per ton			
	Min.	Max.	Ave.	Boston	Min.	Max.	Ave.	Boston
Garbage (7 cities)	798	1,540	936	667	1.3	2.5	2.1	3.0
Rubbish only (5 cities)	200	677	214		2.9	10.0	9.3	
Garbage and combustible refuse (5 cities)	214	800	440	333	2.5	9.3	4.5	6.0
Rubbish and ashes (7 cities)	400	1,000	690		2.0	5.0	2.9	
Ashes and non-combustible rubbish (4 cities)	747	1,165	885		1.7	2.7	2.3	
All refuse together (6 cities)	500	1,000	604		2.0	4.0	3.3	
Ashes only				1,330				1.5
Commercial refuse				250				8.0
Commercial garbage				800				2.5
Street Sweepings				570				3.5

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*In estimating the quantity of refuse produced per day, the 365 day year is generally used, but in estimating the quantity to be collected and incinerated, the 300 day year is commonly used so that the average daily rate of collection and disposal would be 365/300 of the values in the table.

Heat Value of Refuse

The heat value of refuse varies widely. Obviously ashes and other non-combustible refuse have no heat value. Dry garbage and rubbish have a heat value from 5000 to 7500 B.T.U. per pound.

Wet garbage, 80% moisture, has a heat value of only about 1500 B.T.U. per pound.

Carefully drained and wrapped garbage may have a heat value up to 2000 or 2250 B.T.U. per pound. The heat value of combustible refuse varies greatly with the moisture content.

In rainy seasons and in the summer with large amounts of green vegetables used, the moisture content is greater and the heat value less. Some incinerators occasionally require some supplementary fuel during the wet or summer season. Where coal, wood shavings, or wood trimmings are used, this fuel is generally mixed with the refuse in the refuse pit or put into the incinerator furnace through the charging hole where direct charging is the practice. In a few cases oil burners have been installed in the furnace, but the use of oil by this method has not generally proven satisfactory.

Appendix A gives a typical heat balance table for an incinerator.

Description of Typical Plants in Other American Cities

Before proceeding with the design of the Southampton Street Incinerator, a search was made of the literature for design and operating data. As but little information was found, a questionnaire was sent out by the Public Works Commissioner to 67 cities, to which 32 replies were received. Although the replies to this questionnaire indicated a wide variation in practice, much valuable information was obtained. A summary of the results of this questionnaire is given in Appendix B.

To obtain further information, inspections were made by the writer and other members of the staff of Coffin & Richardson, Inc., of the incinerator plants in many cities in the eastern United States and including Toronto, Canada. The particular cities visited were chosen, not only because it was believed that their problems were similar to those of Boston, but also because it was desirable to see as many different types of incinerators as possible. In every city visited we were received with the greatest courtesy and were given every opportunity to examine and inspect these plants.

APPENDIX A - TYPICAL HEAT BALANCE TABLE FOR AN INCINERATOR PLANT

Total Moisture Content of Refuse % by Weight	AVAILABLE HEAT PER LB. REFUSE BTU per lb. of Refuse - Dry Basis					ABSORBED HEAT PER LB. OF REFUSE REFUSE MIXTURE BY WEIGHT						
	7000	6500	6000	5500	5000	100% 0%	80% 20%	75% 25%	70% 30%	65% 35%	60% 40%	Garbage Rubbish
35	4550	4225	3900	3575	3250	2873.7	2886.3	2888.9	2892.0	2895.1	2898.1	
36	4480	4160	3840	3520	3200	2881.8	2894.4	2897.1	2900.2	2903.4	2906.4	
37	4410	4095	3780	3465	3150	2889.9	2902.5	2905.3	2908.5	2911.6	2914.7	
38	4340	4030	3720	3410	3100	2898.1	2910.7	2913.6	2916.7	2919.9	2922.9	
39	4270	3965	3660	3355	2050	2906.2	2918.8	2921.8	2925.0	2928.1	2931.2	
40	4200	3900	3600	3300	3000	2914.3	2926.9	2930.0	2933.2	2936.4	2939.5	
41	4130	3835	3540	3245	2950	2922.3	2935.0	2938.1	2941.4	2944.6	2947.7	
42	4060	3770	3480	3190	2900	2930.4	2943.1	2946.3	2949.5	2952.8	2955.9	
43	3990	3705	3420	3135	2850	2938.4	2951.3	2954.4	2957.7	2960.9	2964.1	
44	3920	3640	3360	3080	2800	2946.5	2959.4	2962.6	2965.8	2969.1	2972.3	
45	3850	3575	3300	3025	2750	2954.5	2967.5	2970.7	2974.0	2977.3	2980.5	
46	3780	3510	3240	2970	2700	2962.5	2975.6	2978.8	2982.2	2985.5	2988.7	
47	3710	3445	3180	2915	2650	2970.6	2983.7	2987.0	2990.3	2993.7	2996.9	
48	3640	3380	3120	2860	2600	2978.6	2991.9	2995.1	2998.5	3001.8	3005.1	
49	3570	3315	3060	2805	2550	2986.7	3000.0	3003.3	3006.6	3010.0	3013.3	
50	3500	3250	3000	2750	2500	2994.7	3008.1	3011.4	3014.8	3018.2	3021.5	
51	3430	3185	2840	2695	2450	3002.7	3016.1	3019.5	3022.9	3026.3	3029.6	
52	3360	3120	2880	2640	2400	3010.6	3024.2	3027.5	3031.0	3034.4	3037.7	
53	3290	3055	2820	2585	2350	3018.6	3032.2	3035.6	3039.0	3042.5	3045.9	
54	3220	2990	2760	2530	2300	3026.5	3040.3	3043.6	3047.1	3050.6	3054.0	
55	3150	2925	2700	2475	2250	3034.5	3048.3	3051.7	3055.2	3058.7	3062.1	
56	3080	2860	2640	2420	2200	3042.5	3056.3	3059.8	3063.3	3066.8	3070.2	
57	3010	2795	2580	2365	2150	3050.4	3064.4	3067.8	3071.4	3074.9	3078.3	
58	2940	2730	2520	2310	2100	3058.4	3072.4	3075.9	3079.4	3083.0	3086.5	
59	2870	2665	2460	2255	2050	3066.3	3080.5	3083.9	3087.5	3091.1	3094.6	
60	2800	2600	2400	2200	2000	3074.3	3088.5	3092.0	3095.6	3099.2	3102.7	
61	2730	2535	2340	2145	1950	3082.2	3096.5	3100.0	3103.6	3107.2	3110.7	
62	2660	2470	2280	2090	1900	3090.1	3104.6	3108.0	3111.6	3115.2	3118.8	
63	2590	2405	2220	2035	1850	3097.9	3112.6	3115.9	3119.6	3123.3	3126.8	
64	2520	2340	2160	1980	1800	3105.8	3120.7	3123.9	3127.6	3131.3	3134.9	
65	2450	2275	2100	1925	1750	3113.7	3128.7	3131.9	3135.6	3139.3	3142.9	
66	2380	2210	2040	1870	1700	3121.6	3136.7	3139.9	3143.6	3147.3		
67	2310	2145	1980	1815	1650	3129.5	3144.8	3147.9	3151.6	3155.3		
68	2240	2080	1920	1760	1600	3137.3	3152.8	3155.8	3159.6	3163.4		
69	2170	2015	1860	1705	1550	3145.2	3160.9	3163.8	3167.6	3171.4		
70	2100	1950	1800	1650	1500	3153.1	3168.9	3171.8	3175.6			

BALANCE LINES

NOTES

- Average Combustion Chamber Temp. - 1600° F.
- Outside Temp. - 70° F.
- Air per lb. Refuse - 4 lbs.
- Garbage plus Rubbish = Refuse
- Subtract 300 BTU's from Absorbed Heat Figures if 400° F. Preheated Air is Used.

Figures shown above the Balance Lines indicate that refuse can be burned theoretically by the heat contained in the refuse as shown in the available heat columns, without the addition of supplementary heat.

Example: Say one pound of refuse consisting of a mixture of 65% garbage and 35% rubbish, with a total moisture content of 49% and containing 6000 BTU is to be burned.

Then: Reference to the available heat column under 6000 BTU and at the 49% moisture line shows 3060 BTU available heat which is 50 BTU more than the required 3010.0 BTU absorbed heat shown under the 65/35% mixture column for combustion without supplementary heat.

The problem of municipal refuse disposal has been given careful study in these cities, and although in several of the cities visited other methods of disposal were also used to some extent, it was agreed that incineration in modern high temperature furnaces was the most sanitary and satisfactory solution.

As these inspections proved of much value and furnished the basis for many of the design features of the proposed Boston plant, a brief description will be given of the incinerators in several of these cities.

Particular note was made during our examination of other plants, not only of the good features, but also of details which could be improved. Credit is given to those designers whose ideas we have incorporated in the design of the proposed Southampton Street Incinerator.

Atlanta, Georgia—Population 1940, 302,288

The Atlanta incinerator plant was built in 1941. The plant was designed by Robert and Co., Inc., Engineers, Atlanta, Ga., and the incinerator equipment by the F. L. Smidth & Co., New York City. The incinerator furnaces, of the rotary kiln type, are unique and of very ingenious design. Refuse is deposited into a receiving bin below grade from which it is picked up by clam shell buckets operated from travelling cranes and discharged into a vibrating hopper. From the hopper the refuse passes down onto a pusher drying grate and from this grate onto a pusher burning grate. From the burning grate the refuse passes to a rotary kiln with its longitudinal axis inclined toward the combustion chamber at the far end. There are 2 duplicate units each rated at 85 tons per day and are operated 24 hours per day 6 days a week. No provision is made for stoking the burning refuse.

Two waste heat boilers are installed in the plant. The steam is sold to the Georgia Power Company.

Ashes are removed by a chain scraper operating in a rectangular water trough.

Tin cans and other metals are salvaged from the ash by means of a rotary screen and sold.

Baltimore, Maryland—Population 1940, 859,100

(No. 3 or Principal Incinerator)

The No. 3 incinerator was built in 1932 according to designs by the Pittsburgh-Des Moines Steel Co. It has a rated capacity of 600 tons per day and is operated 24 hours per day 6 days a week. The incinerator is of the mutual assistance type with 4 furnaces of 4 cells each. The furnaces are designed to burn mixed refuse, and with good separation of combustible from non-combustible refuse, over 700 tons of refuse can be burned in a day. No supplementary fuel is required. The combustion chamber temperature is maintained at 1600° F. to 2000° F.

The plant is well designed and operated and although built in what was originally a non-residential area, the proximity of the incinerator has not prevented a residential development in its vicinity.

This incinerator is also of interest in that it is being operated by a contractor rather than by city forces.

In collecting rubbish; bottles, tin cans and other non-combustibles are put into separate compartments or containers on the truck and put in salvage piles at the entrance to the incinerator before depositing the rest of the rubbish into the refuse bin. This separation is done not because of the salvage value of the materials, but rather to keep "rough stuff" out of the furnaces and to improve combustion.

New Rochelle, New York—Population 1940, 58,408

This plant, of the crane and bin type, is well designed and very efficiently operated. The incinerator consists of two 125 tons per day 4-cell mutual assistance type furnaces designed to burn mixed refuse (ashes, garbage and rubbish). The incinerator furnaces and equipment were designed by the Morse Boulger Co. of New York. The average production of refuse in New Rochelle is about 54 tons per day and this is completely burned in approximately 6 hours. The ash from the incinerator is deposited in adjacent low areas and is found to have considerable fertilizing value. This ash represents a residue of about 20.2% of the total weight of the refuse.

The refuse generally has a high moisture content, but despite this fact and the inclusion of some ashes with the refuse, no supplementary fuel is necessary.

Temperatures above the fire in the furnaces are maintained at from 1500° to 1800° F. Air pre-heaters are used. Excellent records are kept of the amount, character, and weights of the different types of refuse received. Recording pyrometers are located in the office and the operation of the furnaces carefully controlled by noting any sudden changes in the temperatures.

New York City—56th St. Plant
(Just east of the West Side Express Highway)

This incinerator plant, one of the largest in the country, was designed by the Department of Sanitation of the City of New York and put into operation in 1936. It has a rated capacity of 750 tons per day and is normally operated at about 600 tons per day 7 days a week. The incinerator consists of 6 rectangular mutual assistance type furnaces each furnace having 4 cells. The furnaces are designed to burn mixed refuse. Combustion chamber temperatures are maintained at from 1600° F. to 2000° F. Two waste heat boilers are installed and provision was made for two more. Steam is used to heat the plant and to drive electric generators which furnish power for auxiliary equipment. Heat and power is also furnished to a large city owned garage adjoining the incinerator plant. Auxiliary oil burners are installed under the waste heat boilers, but no supplementary fuel is used to burn the refuse.

The plant is well designed and efficiently operated. It is also interesting to note that although the incinerator is located in a built-up residential and commercial area and only 2 miles from Times Square, its operation causes no odors or nuisance.

There are also 11 other incinerators in New York City.

Pittsburg, Pennsylvania—Population 1940, 671,659

The Pittsburgh incinerator, constructed in 1940, is a modern plant of excellent design. It has a rated capacity of 600 tons per day, and is operated to full capacity 24 hours per day 6 days a week. It was designed by the Koppers Company. The 4 furnaces are of the rectangular mutual assistance type and consist of 4 cells each. The furnaces are designed to burn mixed refuse and no supplementary fuel is required. No ashes or commercial refuse is delivered to the plant. The plant is well operated without smoke or odor. Ashes are carried from the plant by means of a chain scraper operating in a water trough under the dumping grates. This results in a clean dustless ash tunnel and is a very desirable feature.

Tonawanda (Town) New York—Population 1945, 40,000
(and Village of Kenmore)

The Tonawanda incinerator consists of a single "Monohearth" furnace designed by The Nichols Engineering and Research Corporation of New York. The furnace has a rated capacity of 100 tons per 24 hours and is normally operated about 9 hours per day. Refuse, which consists of rubbish and garbage, comes mainly from residential areas. The plant as a whole was designed by Nussbaumer and Clarke, Engineers of Buffalo and was well planned and is carefully maintained and operated.

Washington, D. C.—Population 1940, 663,091
(Georgetown Incinerator)

The Georgetown incinerator, built in 1932, was designed to burn rubbish only and no garbage or ashes are received at the plant. It has a rated capacity of 170 tons per day and is operated 24 hours per day 5½ days a week. The incinerator consists of 2 mutual assistance furnaces each having 2 cells. No supplementary fuel is required. The plant was designed by Metcalf and Eddy, Engineers, of Boston.

The incinerator is located in the heart of a high grade residential section and is an excellent example of a mechanically well designed and architecturally pleasing structure.

A second incinerator, of 425 tons per day capacity, is located on O street. This plant is of the same general type as the Georgetown plant and was also designed by Metcalf and Eddy.

PRESENT METHOD OF COLLECTION AND DISPOSAL IN BOSTON

Approximately 80% of the garbage and mixed refuse, exclusive of commercial garbage and refuse is collected by contract, and 20% by City Forces. This refuse is collected from 16 general collection districts. In addition several street sweeping patrols are also maintained. Refuse from these several districts is taken to the following disposal stations, owned and maintained by the city:

Fort Hill Wharf, Atlantic Avenue; Albany Street Wharf near City Hospital; Victory Road Wharf, Neponset; all owned and maintained by the city.

Mile End Road Dump, Calf Pasture, South Boston, owned and maintained by the contractor.

At the first three of these depots, refuse is dumped from the collecting trucks into scows and towed to Spectacle Island in Boston Harbor for ultimate disposal by a contractor. At Mile End Road refuse is dumped onto tidal flats to form solid fill. A log boom prevents the material from floating away on the tide.

In addition to the refuse collected by contract and City Forces, private collectors also make collections and dispose of the refuse, by delivering it either to the general contractor, who maintains the above receiving stations, or to other disposal points. Garbage from the larger restaurants and hotels is generally collected separately and delivered to farmers for hog feeding. Commercial refuse is generally collected by private contractors and paid for by the individual owners of the properties from which the refuse is collected. In some areas household garbage is collected separately. In others, it is mixed with other refuse, ashes and rubbish. The character of the refuse varies considerably in different parts of the city.

REASONS FOR PROPOSING INCINERATION IN BOSTON

1. Incineration of municipal refuse in modern high temperature furnaces has become the accepted practice in all progressive modern American cities.

2. With a properly designed, maintained, and operated incinerator, an appreciable saving can be made over the present cost of disposal.

3. By designing the incinerator of ample capacity so that it is economically practicable to utilize the heat from the burning refuse in waste heat boilers, steam can be generated for heat and power. The proposed site on Southampton Street was chosen for its proximity to the City Hospital and other city facilities in this area, so that a steam line can be run from the incinerator to furnish heat and power for these facilities.

4. As the proposed incinerator is designed for steam production it is essential that sufficient refuse be delivered to the plant in accordance with a carefully prepared schedule in order to maintain constant steam production. This requirement will be an inducement to collecting as much refuse as possible, thus increasing the efficiency of the present collecting system—and will result in a much cleaner city.

5. It will eliminate the present unsightly dump at Spectacle Island, which all ships must pass in entering Boston Harbor.

6. Although the proposed incinerator will not care for the needs of the entire city, it is hoped that it will point the way to the development of additional plants, so that eventually the disposal of Boston's refuse on burning dumps will be entirely eliminated.

TABLE 3.—QUANTITY OF REFUSE COLLECTED IN BOSTON—1940—POP. 770,816

Type of Refuse	%	TONS Per Year	TONS Per Day*	CUBIC YARDS Per Year	CUBIC YARDS Per Day	POUNDS PER CAPITA Per Year	POUNDS PER CAPITA Per Day	DENSITY Cu. Yds/ Ton	DENSITY Lbs./ Cu. Yds.	DENSITY Lbs./ Cu. Ft.
Unmixed Garbage	12.6	44,190	147.3	132,570	441.9	114	.38	3.0	667	25
Rubbish and Garbage	36.6	128,720	429.1	772,320	2,574.4	334	1.11	6.0	333	12
Ashes	33.5	117,720	392.4	176,580	588.6	305	1.02	1.5	1,333	49
Commercial Refuse	6.4	22,480	75.1	179,840	599.5	58	.19	8.0	250	9
Commercial Garbage	.3	1,080	3.6	2,700	9.0	3	.01	2.5	800	30
Street Swepings	10.6	37,150	123.9	129,990	433.3	96	.32	3.5	571	21
Total	100.00	351,340	1,171.4	1,394,000	4,647.0					
Total less ashes	66.5	233,620	779.0	1,217,420	4,058.4					
Average						913	3.03	4.0	500	19
Average less ashes						604	2.01	5.2	378	14

*300 days. If the amount per calender day is used the per diem figures should be multiplied by 300/365.

The Proposed Southampton Street Incinerator

General Description of Plant

The incinerator is of the high temperature multi-cell mutual assistance type with 4 furnaces of 4 cells each, the heat from each cell being utilized to evaporate the moisture from fresh charges of refuse in adjacent cells.

Each furnace has a capacity of 150 tons of mixed refuse per day, making a total installed capacity of 600 tons per day.

The hot gases from the burning refuse pass through the combustion chamber and into waste heat boilers.

Two 1100 H.P. water tube boilers are provided, each rated at 38,000 pounds of steam per hour at 175 P.S.I.

Location

The proposed incinerator is to be located at the corner of Southampton and Atkinson Sts., on land now owned by the City of Boston. This site was chosen because of its proximity to the City Hospital, its central location, and the ease with which refuse trucks can enter and leave the plant without interfering with traffic. This site has the further advantage that if plans which have been made in the past for filling in the old Roxbury Canal and South Bay are carried out, a most convenient area is available adjacent to the plant for the disposal of the residue and ashes from the incinerator.

Area and Population to Be Served

There is a population of 337,220 within a two mile radius of the incinerator. This area includes South Boston, the South End, the Back Bay, North Dorchester and Roxbury. Within the area between the two and the two and one-half mile radius there is an additional population of 87,720, making a total population within the 2½ mile radius of the incinerator of 424,940 people, or 55% of the total population of the city. Of this total 360,000 is assumed to be the normal population contributing refuse to the Southampton Street incinerator. It has already been pointed out that an ample supply of combustible refuse must be constantly delivered to the incinerator if it is to be efficiently maintained as a steam plant. As the heat value of the refuse varies widely with the season and the weather, a reserve source of refuse must be readily available. This is provided in the area between the 2 and 2½ mile circles. Fig. 1 shows the location of the incinerator and the tributary population, and Fig. 2 is the site plan.

Quantity of Refuse and Plant Capacity

Assuming a per capita production of refuse from the above 360,000 persons of 2.0 pounds 365 days a year, 438 tons per day must be collected and disposed of on 300 days of the year. The plant was, therefore, designed for a normal operating capacity of 450 tons per day with a fourth furnace for reserve and peak demands.

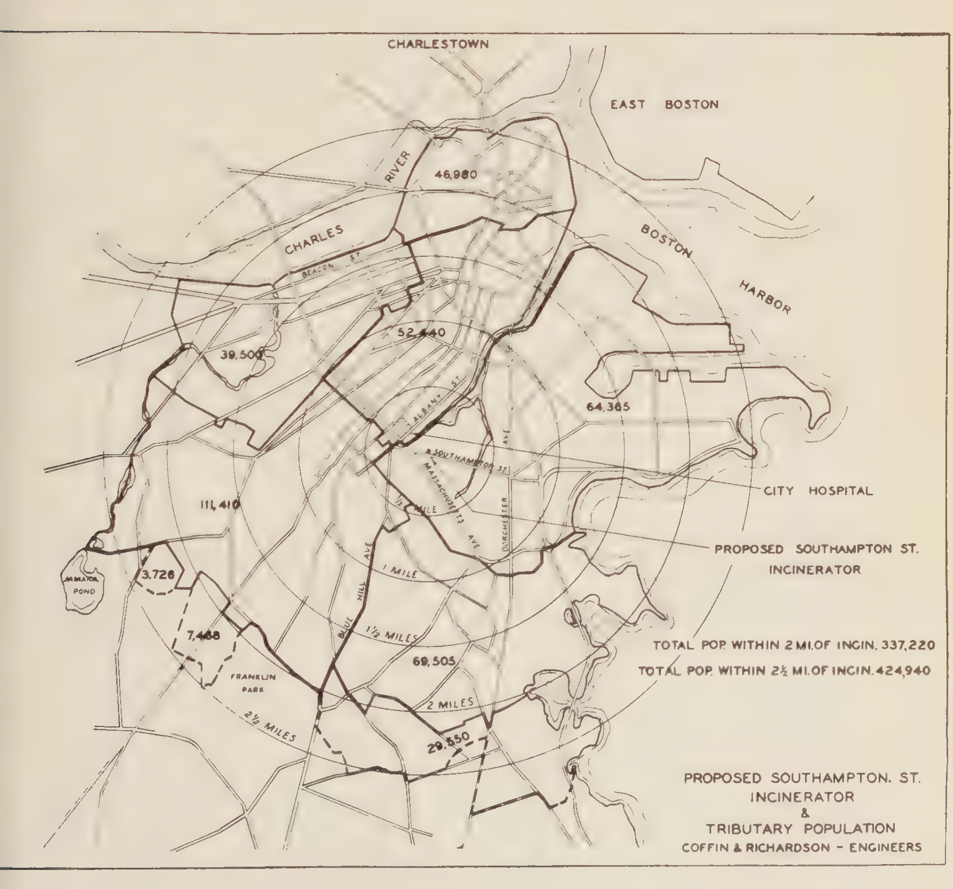


FIG. 1.

Basis of Design

The following 6 basic considerations governed the design:

1. The requirement that the incinerator be designed to utilize the heat from the burning refuse for steam generation to develop power and to heat the City Hospital.
2. That for efficient operation there should be no bottle necks in the plant.
3. That the plant should be of ample capacity for all normal demands with a reasonable allowance for seasonal and peak requirements.

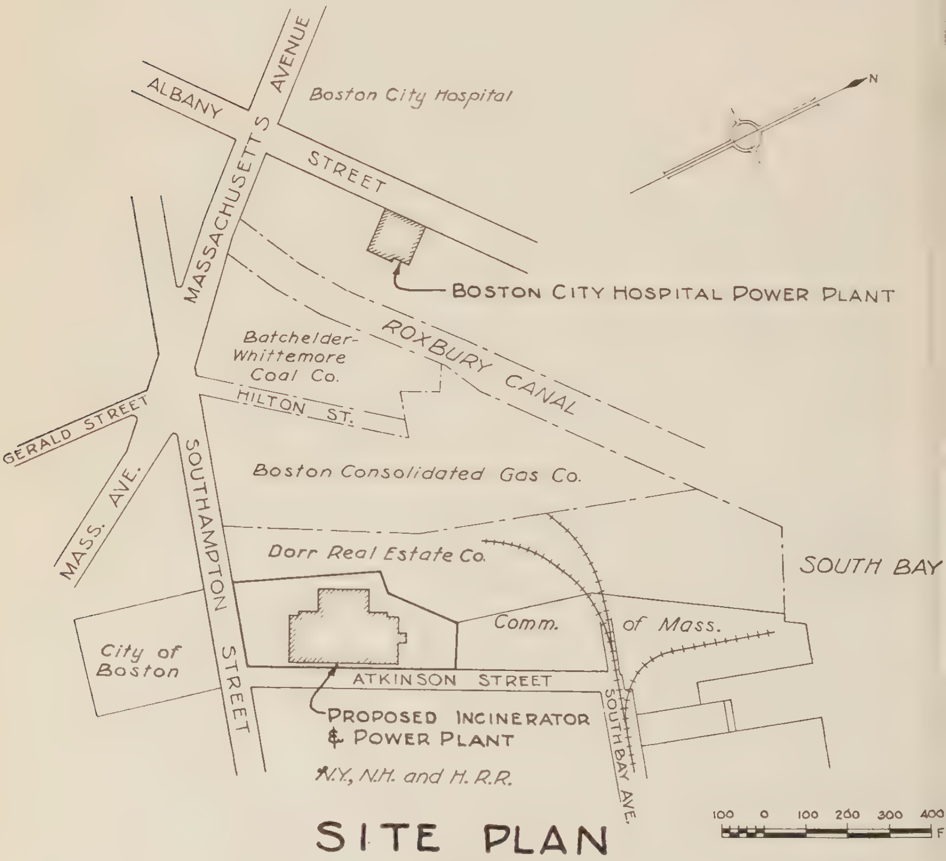


Fig. 2.

4. That equipment should be rugged and designed for easy operation and economical maintenance.
5. That the plant be able to dispose of refuse as it comes. 100% separation is impracticable and the incinerator furnace and other equipment must be able to handle a certain amount of "rough stuff".
6. That ample space be provided on the tipping floor for the largest trucks that may be expected to bring refuse to the plant and that the approach to, and exit from the plant be so as to prevent traffic delays.

The design of an incinerator is essentially a problem in combustion engineering with a very low grade fuel of widely varying heat value substituted for the usual homogeneous high heat value fuels. Experience in other cities and tests by manufacturers of incinerator furnaces have shown that refuse consisting of a mixture of 65% garbage with a moisture content of 80%, and 35% rubbish with a moisture content of 15% will burn without other fuel if efficiently designed air pre-heaters are used.

As steam is to be generated 24 hours a day, the refuse pit was designed of sufficient capacity to operate the plant during the 16 hours of the day when no refuse is received, plus a reserve capacity to care for variations in the density of the refuse, and to provide storage on days when larger than normal amounts of refuse are collected. Refuse collections in Boston are generally made during an 8-hour day 5½ days a week or on an average of 300 days a year.

It will probably be found impracticable to operate the incinerator more than 6 days a week. Therefore, to maintain steam over the Sunday week end and at other times when necessary, auxiliary oil burners are provided under the waste heat boilers. With the incinerator boilers in operation it will be more practicable and economical to keep these in continuous operation rather than to allow them to cool off and start up the hospital boilers for only one day's use a week.

The ideal location for an incinerator would be on a side hill so that the refuse can be fed to the furnaces from the refuse bin by gravity. Where no side hill is available, some means must be provided to elevate the refuse from the street level to the charging hoppers. Many ingenious devices have been proposed and in some cases used. High ramps would have required more land than was available at the Southampton Street site, and they are objectionable from the standpoint of maintenance in cold and stormy weather. Various types of mechanical elevators, such as skip hoists, belt conveyors, etc., have been proposed and tried. The objection to the use of any of these devices is due to the large and heavy mechanical equipment necessary to handle the extremely bulky and tangled refuse. It was accordingly decided to provide for storage of the refuse in a pit below grade and to raise the refuse to the charging hoppers by the means of cranes and buckets.

Fig. 3 shows a general plan of the incinerator and Fig. 4 shows a longitudinal section through the furnaces and a section through a furnace and air pre-heater. Appendix C shows the flow diagram of the incinerator and waste heat steam plant.

Entrance and Exit

Refuse is delivered to the incinerator from Atkinson Street by driving up an 8% ramp to the tipping floor. The tipping floor is about 5 ft. above the street level. Exit from the plant is down an 8% ramp to Southampton Street. Entrance and exit doors are of the overhead motor operated roller type. The doors, each 14′ wide by 14′ high, are provided at both entrance and exit.

Scales

Two 20 ton 10′ x 24′ platform scales are located just inside the entrance doors with a weighmaster's office between them. The scales are provided with a printing attachment to keep a record of the weight of all refuse delivered to the plant. With careful weighing of refuse and an accurate means of determining the time of arrival of each truck at the plant, an efficient collecting schedule will result.

Tipping Floor

The tipping floor is 45′ wide between the tipping log and a 3 foot side walk on the side away from the refuse pit. It is 264 feet long from door to door. The tipping floor was designed of generous proportions to prevent traffic congestion during peak deliveries.

Refuse Pit

The refuse pit is 19′10″ wide x 18′6″ deep below the tipping floor and 215′2½″ long. It has a capacity of 2840 cu. yds. This capacity provides for storage of refuse for night operation when no refuse is

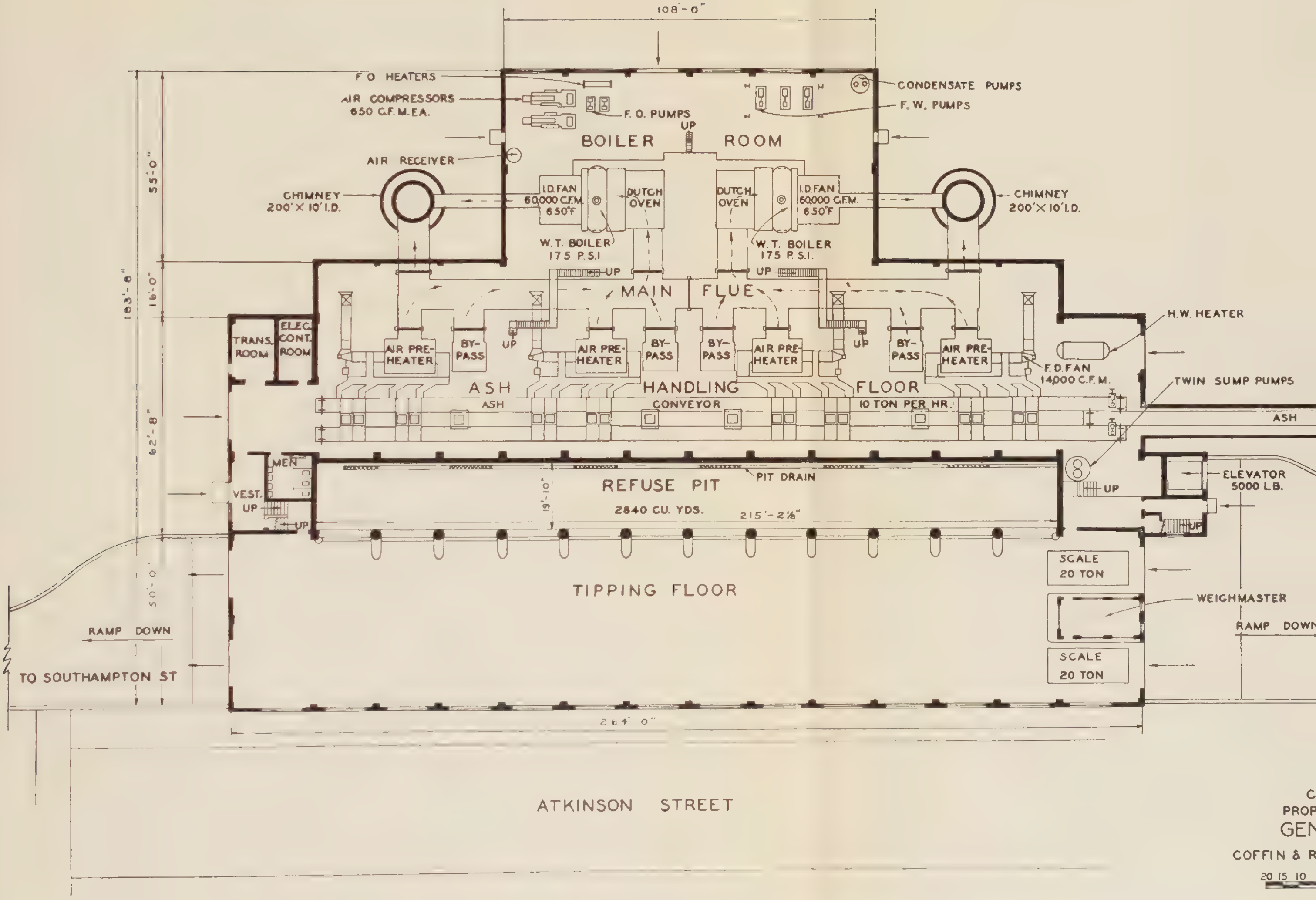
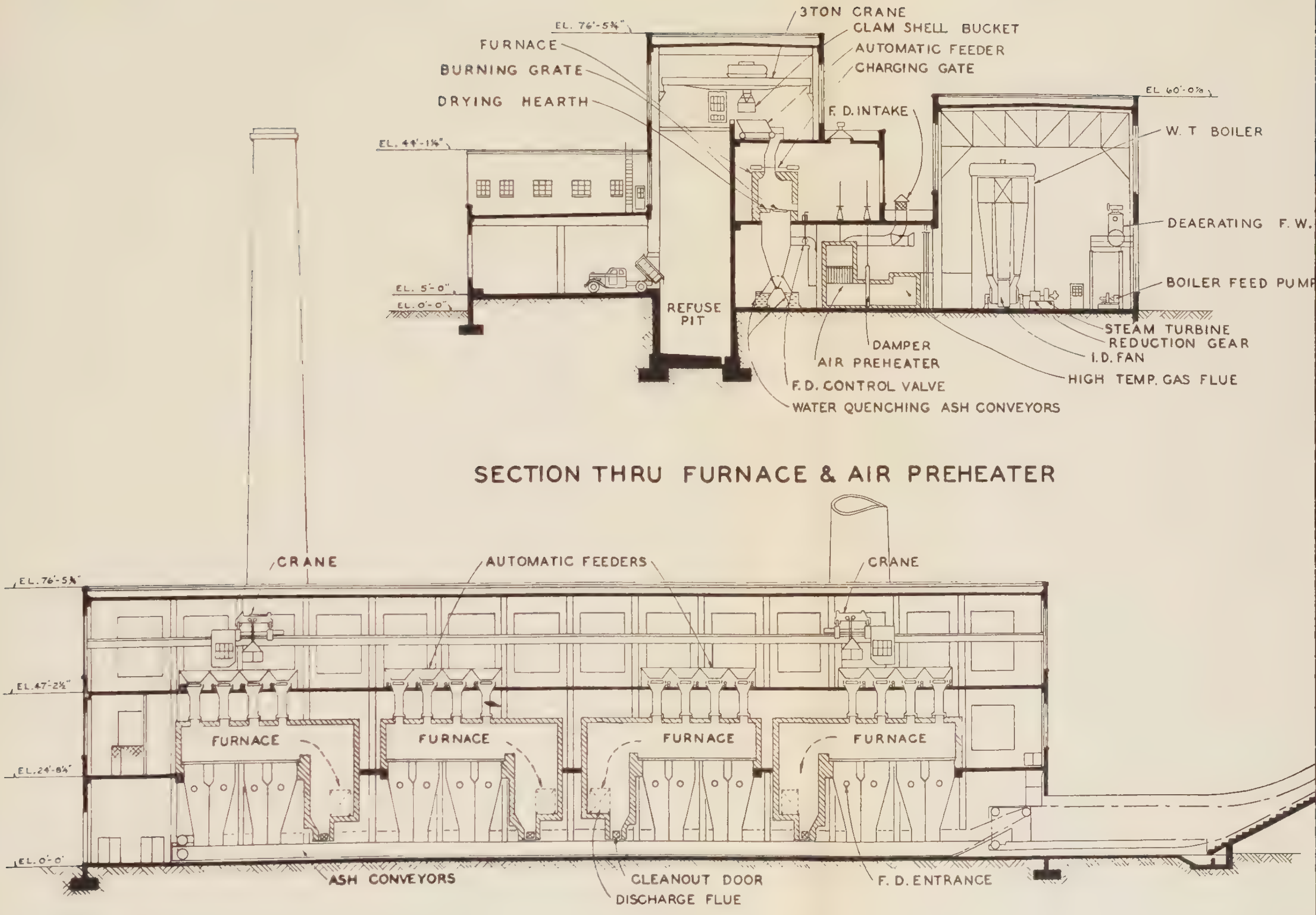

108'-0"
F O HEATERS
AIR COMPRESSORS 650 C.F.M. EA.
F. O. PUMPS
CONDENSATE PUMPS
F. W. PUMPS
UP
BOILER ROOM
AIR RECEIVER
CHIMNEY 200' X 10' I.D.
I.D. FAN 60,000 C.F.M. 650°F
DUTCH OVEN
W. T. BOILER 175 P.S.I.
CHIMNEY 200' X 10' I.D.
55'-0"
16'-0"
183'-8"
62'-8"
50'-0"
MAIN FLUE
TRANS. ROOM
ELEC. CONT. ROOM
AIR PRE-HEATER
BY-PASS
H.W. HEATER
F.D. FAN 14,000 C.F.M.
TWIN SUMP PUMPS
ASH HANDLING FLOOR
ASH CONVEYOR 10 TON PER HR.
ASH
MEN
VEST.
PIT DRAIN
REFUSE PIT
2840 CU. YDS.
19'-10"
215'-2⅛"
ELEVATOR 5000 LB.
SCALE 20 TON
WEIGHMASTER
TIPPING FLOOR
RAMP DOWN
TO SOUTHAMPTON ST
264'-0"
ATKINSON STREET
C
PROP
GEN
COFFIN & R
20 15 10

FIG. 3.



SECTION THRU FURNACE & AIR PREHEATER

LONGITUDINAL SECTION THRU FURNACES

Fig. 4.

ordinarily received, plus a reserve for peak deliveries. The pit is lined with ¼″ steel plate on the sides to protect the concrete. The bottom is lined with railroad rails. The bottom is pitched to a longitudinal drain which discharges into a sump at the northerly end of the building.

Cranes and Buckets

The crane and bucket method of raising the refuse from the pit to the charging floor appeared to be the most practicable. The use of clamshell buckets has the added advantage of breaking up large and bulky articles, such as crates, barrels, etc., before depositing them into the charging hoppers. Two high speed travelling cranes are provided and a third may be installed later if found desirable. The cranes have a rated capacity of 3 tons each and a span of 41 ft., and a hoist of 66 feet. Operating speeds are as follows:

Bridge	300 ft. per minute
Trolley	200 ft. per minute
Hoist	220 ft. per minute

A 2 cu. yd. clamshell bucket is provided with each crane. Experience in other cities has shown that buckets of this capacity will usually pick up from 2½ to 3 cu. yds. of refuse. With both cranes in operation at maximum capacity, they will handle 200 cu. yds. of refuse per hour.

Charging Hoppers

Each furnace cell is provided with a charging hopper on the charging floor and a charging chute between the hopper and the furnace. The hoppers have a capacity of 6.24 cu. yds. each or about one-half hour's supply of refuse at the normal burning rate of each cell. The hoppers are equipped with motor driven apron conveyors to feed the refuse into the chutes at a rate which can be varied according to the character of the refuse and the requirements of the furnace operator. The charging chute has a capacity of about 1½ cu. yds., the maximum charge considered desirable to put into the furnace at one time. The charging chute is equipped with refractory lined gates just above the furnace cells. When open, these gates provide a 2′8″ square clear opening and can be either manually or automatically operated. Automatic operation is by means of compressed air jacks. The frequency of the opening and closing of gates is synchronized with the speed of the apron conveyor in the hopper so as to feed refuse into the furnace at as near a uniform rate as practicable.

Fig. 5 shows a general plan of the operating floor and the arrangement of the furnaces and combustion chambers.

Furnaces

Each furnace consists of four cells in parallel with a combustion chamber at the end. They are designed to burn refuse with a combustion chamber temperature of from 1500° F. to 1800° F. with air preheaters. Each cell has a drying grate, burning grate, and ash dumping section. The drying grate is at the rear of the cells under the charging chute and has an area of 26 square feet (8′ wide x 3′3″ deep). The burning grate has an area of 50 square feet (8′ wide x 6′3″ deep). The overall dimensions of the grates and dumping sections of each cell are 8′ wide x 9′6″ deep. Total grate area of each furnace is 304 sq. ft. (32′ x 9′6″). The furnaces are made as shallow as practicable in order to make their operation as easy as possible, and to reduce the labor of stoking to a minimum. There are no bridge walls in the furnaces. The principal constants used in the design of the furnaces are as follows:

	Sq. ft. per ton of refuse per 24 hours
Drying Grate	0.6
Burning Grate	1.2
	1.8

	Cu. ft. per ton of refuse per 24 hours
Furnace (4 cell)	11.0
Combustion chamber	15.0
	26.0

The furnaces, flues and chimneys are all refractory brick-lined. Dampers are designed for construction of Duralloy, a high heat-resistant metal which will make them much lighter than the conventional refractory lined or water cooled dampers.

A light and well ventilated stoking aisle 20 feet wide runs the entire length of the furnace room.

A carcass door 4′ x 6′ for dead animals is provided in the combustion chamber of No. 1 furnace.

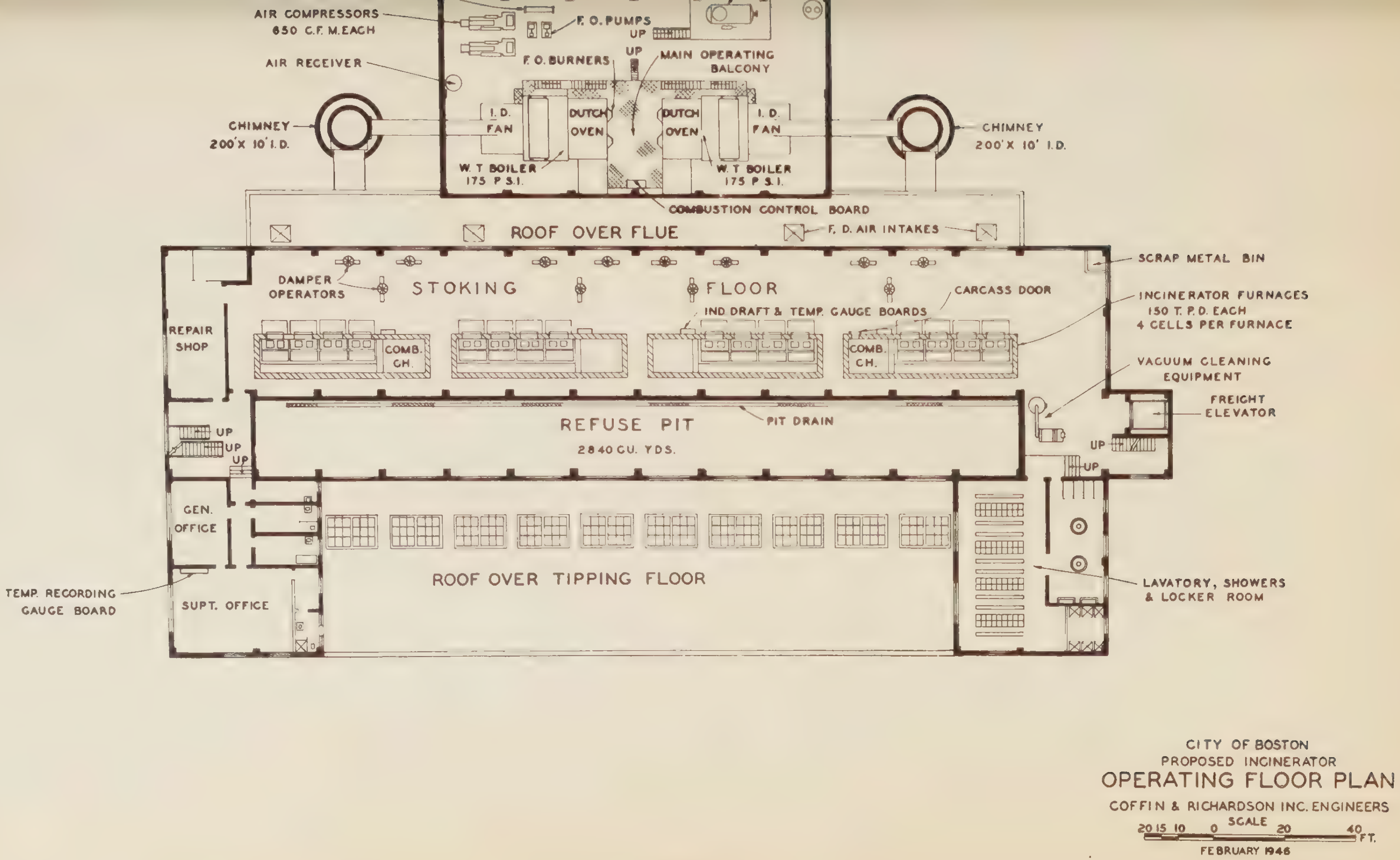

AIR COMPRESSORS
650 C.F.M. EACH
AIR RECEIVER
F. O. PUMPS
UP
UP
F. O. BURNERS
MAIN OPERATING BALCONY
CHIMNEY
200'X 10' I.D.
I. D. FAN
DUTCH OVEN
DUTCH OVEN
I. D. FAN
CHIMNEY
200'X 10' I.D.
W. T. BOILER
175 P.S.I.
W. T. BOILER
175 P.S.I.
COMBUSTION CONTROL BOARD
ROOF OVER FLUE
F. D. AIR INTAKES
SCRAP METAL BIN
DAMPER OPERATORS
STOKING FLOOR
CARCASS DOOR
IND. DRAFT & TEMP. GAUGE BOARDS
INCINERATOR FURNACES
150 T. P. D. EACH
4 CELLS PER FURNACE
REPAIR SHOP
COMB. CH.
COMB. CH.
VACUUM CLEANING EQUIPMENT
FREIGHT ELEVATOR
UP
UP
UP
REFUSE PIT
2840 CU. YDS.
PIT DRAIN
UP
UP
GEN. OFFICE
TEMP. RECORDING GAUGE BOARD
SUPT. OFFICE
ROOF OVER TIPPING FLOOR
LAVATORY, SHOWERS & LOCKER ROOM
CITY OF BOSTON
PROPOSED INCINERATOR
OPERATING FLOOR PLAN
COFFIN & RICHARDSON INC. ENGINEERS
SCALE
20 15 10 0 20 40 FT.
FEBRUARY 1946

Fig. 5.

Flues

The high temperature gas flues have a cross section area of 57 feet and are designed for low velocities of the hot gases to allow the separation of the fly-ash. Velocities in the flues will not exceed 27 feet per second.

Chimneys

Two refractory brick lined chimneys are provided. The chimneys are 10′0″ inside diameter at the top and 200 feet high above street level.

Air Pre-heaters

An air pre-heater with 340 cast iron tubes is provided for each furnace. By the use of the pre-heaters, five pounds of air at 400° F. per pound of refuse can be supplied. The pre-heaters can be by-passed when not needed.

Forced Draft

Forced draft fans having a capacity of 14,000 c.f.m. are provided for each furnace. These fans are nominally operated by 20 H.P. electric motors. Auxiliary steam turbines are also provided for each fan to maintain an even steam balance. The forced draft fans will ordinarily take air from outside the building so as to assure an ample supply of oxygen for combustion, and will operate under a static pressure of 5″ of water. All operating draft dampers are controlled from the operating or stoking floor.

Indicating and Recording Instruments

Indicating instruments are located at each furnace and recording instruments are located in the Superintendent's office. The following schedule indicates the location and function of the various indicating and recording instruments:

TABLE 4.—INDICATING AND RECORDING INSTRUMENTS

Stoking Floor

One gauge board on each incinerator furnace.

Each board has draft gauges and pyrometers to indicate:

- a. Forced draft pressure under each cell grate.
- b. Induced draft in combustion chamber.
- c. Temperature of forced draft air to furnace.
- d. Temperature of gas in combustion chamber.

Boiler Operating Balcony

One gauge board for instruments and combustion control.

The board has instruments as follows:

- a. Gauge to indicate and record steam pressure.
- b. Draft gauges to indicate induced draft in and out of each boiler.
- c. Pyrometers to indicate temperature of gases in and out of each boiler.
- d. Flow meter to indicate and record pressure, temperature and quantity of boiler feed water.
- e. Flow meters to indicate and record the quantity of steam from each boiler to the steam header and from the header to the City Hospital Power Plant.

Office

One gauge board.

This board has pyrometers to indicate and record as follows:

- a. Temperature of forced draft air to each incinerator furnace.
- b. Temperature of gases of combustion in each incinerator furnace combustion chamber.
- c. Temperature of gases in and out of each steam boiler.

Combustion Control System

The object of the combustion control system is to maintain uniform steam pressure and draft at the incinerator furnaces irrespective of the steam demand. This is accomplished as follows:

- a. Regulation of steam pressure by control of the speed of the induced draft fans.
- b. Control of oil burners when in use by regulating the amount of oil supplied to the burners.
- c. Control of the draft in the incinerator furnaces by means of diaphragm pilot valve operated master controllers connected to the main high temperature gas flue between the incinerator furnaces and the boilers.
- d. These master controllers govern the operation of compressed air jacks which operate the main dampers between the high temperature gas flue and the chimneys.
- e. The controls for the combustion control system are mounted on the gauge board on the boiler operating balcony.

Operation

In case the demand for steam is reduced to a point below the capacity of the incinerator furnaces, the increase in steam pressure will operate the combustion control regulator which, in turn, will slow down the induced draft fans, thereby reducing the amount of incinerator gases to the boilers. This, in turn, will reduce the draft in the main high temperature gas flue and operate the master draft controllers, which, in turn, will cause the compressed air jacks to open the dampers between the main gas flues and the chimneys which are designed to maintain sufficient draft to operate the incinerator furnaces direct in case the waste heat boilers and induced draft fans are not operating.

All parts of the system regulated by the combustion control system may be operated automatically or manually.

Ash Hoppers and Conveyors

Ashes from the furnaces are dumped by means of tipping grates at the front of the furnaces through water sealed chutes into a trough containing water. The trough is one of a pair running the entire length of the ash tunnel beneath the furnaces. Ashes are removed from the trough by a chain scraper conveyor to a bin outside the plant. Two conveyors are provided so as to insure continuous operation of the plant while one conveyor is out of service for occasional repairs.

Boiler Plant

Two vertical high pressure water tube boilers are installed in an adjoining building at the rear of the incinerator plant. The high temperature (1800° F.) gases from the incinerator pass through the boilers, generating steam at 175 P.S.I. saturated. The boilers are rated at 38,000 pounds of steam per hour (1100 H.P.). Steam is delivered to the City Hospital Power Plant through a 10″ main. The average daily steam demand at the City Hospital is about 50,000 lbs. per hour.

Each of the waste heat boilers is equipped with direct high pressure atomizing oil burners to maintain continuous production of steam when the incinerator furnaces are not operating.

These burners are designed for manual starting and either manual or automatic operation regulated by the combustion control system.

They will probably be needed occasionally during the first few years of operation until as high a degree of separation of combustible from non-combustible refuse as possible is obtained.

Accessory Mechanical Equipment

Soot Blowers—Boilers and air pre-heaters are equipped with semi-automatic soot blowers to maintain constant efficiency.

Vacuum System—Soot and fly ash is removed from the incinerator flues, boilers, and chimneys by a vacuum system which automatically empties into the wet ash conveyor. The system has a capacity of 150 lbs. of dust per minute.

Boiler Feed Water Heater—Boiler feed water is heated by a deaerating heater having a capacity of 80,000 lbs. (9600 gals.) per hour with 10 minute water storage.

Steam Turbines—Steam turbines are used to drive the boiler feed pumps and the induced and forced draft fans. Steam turbines are used to assure continuous service, provide an even steam balance, and to eliminate oil in the boiler feed water. Exhaust steam from the turbines is used for heating boiler feed and service water and also building heating.

Hot Water Storage Tank—A 3000 gal. hot water storage tank is provided to supply hot water for cleaning and flushing connections throughout the plant. It is designed to heat 3000 gals. per minute from 65° F. to 140° F. with steam at 5 P.S.I.

Freight Elevator—A 5000 lb. capacity freight elevator with an 8′ x 10′ platform is located at the north end of the building and runs from the street level to the stoking and charging floors.

Air Compressors

Two single stage constant speed air compressors.
Capacity each: 650 C.F.M. free air to 100 P.S.I.G.
Drive: 2—100 H.P. Synchronous motors
Power transmissions: V Belts
Regulation: Suction Unloaders
Synchronous motors are used for power factor correction.
Compressors provide air for operating incinerator, charging gates, combustion control and general use.

Electrical Equipment—The plant contains electric motors ranging in size from the 100 H.P. air compressor motors to fractional horse power motors for minor equipment. These motors have a total connected load of 636 H.P. Current is supplied through a 300 K.V.A. transformer at the south end of the building. The following table lists the principal motor driven equipment:

TABLE 5.—ELECTRIC MOTORS—440 VOLT 3 PHASE 60 CYCLES

	H.P. Each	Number	H.P. Total
Charging Floor			
Two Overhead Traveling Bridge Cranes			
Hoists	30	4	120
Trolley	3	2	6
Bridge	15	2	30
Freight Elevator	30	1	30
Charging Hoppers	3	16	48
Stoking Floor			
Vacuum Producer	30	1	30
Tipping Floor			
Sump Pumps for Refuse Pit	3	2	6
Forced Draft Fans	20	4	80
Ash Conveyors	7.5	2	15
Ash Conveyor (In ash hopper)	7.5	1	7.5
Boiler Room			
*Air Compressors	100	2	200
Boiler Feed Pump	40	1	40
Condensate Return Pumps	3	2	6
Total		40	618.5
Total connected motor load including fractional H.P. Motors, approx.			636 H.P.
Estimated average load factor			50 %
Main Transformer			300 K.V.A.

*Synchronous motors.

Structural

The entire plant is of steel frame, brick and reinforced concrete carried on piles.

Architectural

The plant is of simple functional design with red brick facing and steel sash windows. Glazed tile for cleanliness is used in the interior.

General

Ample light and ventilation both natural and artificial are provided throughout the entire plant.

DING TRUCK SCALES

LLING CRANE
LLS

6 COMBUSTION CHAMBER
7 GAS FLUES
8 AIR PREHEATERS
9 BOILER
10 TURBINE DRIVEN I.D. FAN

11 CHIMNEY
12 OIL BURNERS
13 FORCE DRAFT FAN
14 STEAM TURBINE
15 ELECTRIC MOTOR
16 F.D. INTAKE
17 MAKE UP STATION

18 STEAM TURBINE
19 FEED WATER HEATER
20 BOILER FEED PUMPS (STEAM)
21 BOILER FEED PUMP (ELECTRIC)
22 CITY HOSPITAL F.W. HEATER
23 LIQUID LEVEL CONTROLLED RHEOSTAT
24 ELECTRIC MOTOR DRIVEN VARIABLE SPEED POSITIVE DISPLACEMENT PUMPS
25 CONDENSATE PUMP

26 FUEL OIL HEATERS
27 FUEL OIL PUMPS
28 THERMOSTATIC CONTROL
29 FUEL OIL TANKS
30 STEAM SEPARATOR
31 REDUCING VALVE
32 SAFETY VALVE
33 STOP & CHECK VALVE
34 CITY HOSPITAL STEAM MAIN

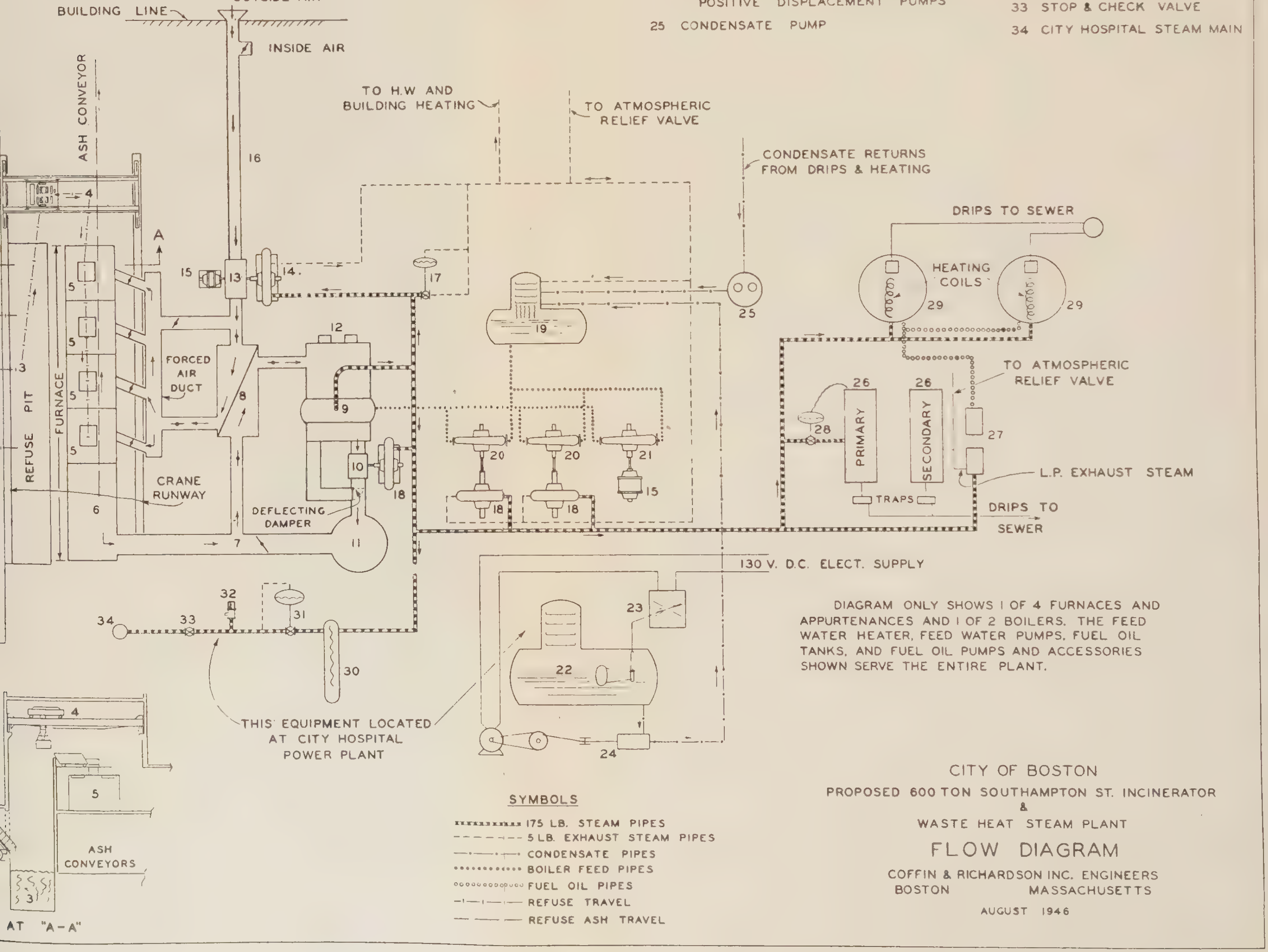


DIAGRAM ONLY SHOWS 1 OF 4 FURNACES AND APPURTENANCES AND 1 OF 2 BOILERS. THE FEED WATER HEATER, FEED WATER PUMPS, FUEL OIL TANKS, AND FUEL OIL PUMPS AND ACCESSORIES SHOWN SERVE THE ENTIRE PLANT.

SYMBOLS

175 LB. STEAM PIPES
5 LB. EXHAUST STEAM PIPES
CONDENSATE PIPES
BOILER FEED PIPES
FUEL OIL PIPES
REFUSE TRAVEL
REFUSE ASH TRAVEL

CITY OF BOSTON
PROPOSED 600 TON SOUTHAMPTON ST. INCINERATOR
&
WASTE HEAT STEAM PLANT

FLOW DIAGRAM

COFFIN & RICHARDSON INC. ENGINEERS
BOSTON MASSACHUSETTS
AUGUST 1946

Office Space and Washrooms

Office space, a first aid room and toilet facilities are provided at the southerly end of the building for office personnel, and lockers, shower baths, and toilet facilities for the operating personnel are located at the northerly end of the building.

Machine Shop

A small machine shop for minor repairs is located on the second or operating floor.

ACKNOWLEDGMENTS

The writer is pleased to acknowledge with thanks the following, whose interest and assistance have contributed to the design of the proposed Southampton Street Incinerator and steam plant:

Mr. William T. Morrissey, former Commissioner of Public Works for the City of Boston, under whose direction the design was begun.

The Boston Finance Commission, for their support and interest in the project.

Mr. James F. Sanborn of Sanborn & Fitzpatrick, Consulting Engineers, New York, who reviewed the design and by his sound judgment rendered much valuable assistance.

Mr. Willard S. Little, Senior Sanitary Engineer, Massachusetts Department of Public Health, who furnished valuable data on refuse collection and disposal and who also reviewed the plans.

Mr. Frederick Sullivan, Chief Engineer of The Boston City Hospital who furnished valuable data on the steam requirements and operation of the hospital power plant.

Mr. William F. Converse, Mechanical Engineer, Coffin & Richardson, Inc., who prepared the detailed design of the incinerator, power plant, and equipment.

The many manufacturers of mechanical and other equipment who furnished technical and operating data.

The officials of the several cities visited and those designers of other plants whose ideas have been incorporated in the design of the Boston Plant.

Mr. Edward M. Richardson of Coffin & Richardson, Inc., formerly Public Works Commissioner for the City of Boston, for his unfailing interest, sound advice, and helpful assistance.

Of General Interest

HARVARD AND MASSACHUSETTS INSTITUTE OF TECHNOLOGY MAKE APPOINTMENTS

GORDON M. FAIR

Gordon M. Fair, Professor of Sanitary Engineering at Harvard University, has been appointed dean of the Graduate School of Engineering, succeeding Professor H. M. Westergaard who will continue at the school as Gordon M. McKay Professor of Civil Engineering.

Dean Fair, a native of South Africa, attended the Charlottenberg Technical Gymnasium in Germany as well as the Massachusetts Institute of Technology, receiving the degree of Bachelor of Science from the latter and also from Harvard in 1916.

He began his career at Harvard in 1918 as an instructor in Sanitary engineering. Since 1935 he has been professor of Sanitary Engineering.

In 1921 he served as assistant director of Sanitation for the League of Red Cross Societies in Geneva. He has been a consultant to the Institute of Inter-American Affairs since 1943 and has participated in the organization of cooperative health and sanitation activities in many nations of South America.

Dean Fair is a member of the American Society of Civil Engineers and of the Boston Society of Civil Engineers and was President of the Society 1939-40.

JOHN B. WILBUR

Dr. John B. Wilbur, professor of structural engineering at the Massachusetts Institute of Technology, has been appointed head of the Department of Civil and Sanitary Engineering. Dr. Wilbur has been acting head of the department since June, 1944, following the death of Theodore B. Parker, its head at that time.

A native of Oakland, Maine, Professor Wilbur was educated at the Academy High School in Erie, Penn., and the Institute, from which he was graduated in 1926. He was awarded the degree of Master of Science in 1928 and his doctorate in 1933. Professor Wilbur served as an assistant in his department from 1926 to 1928 when he joined the engineering staff of the Maine Central Railroad Company. From 1929 to 1930 he was a bridge designer for the New York Central Railroad Company in New York. In 1930 Professor Wilbur returned to the Institute as an instructor in civil engineering and was promoted to the rank of assistant professor in 1934. He was appointed an associate professor in 1937 and professor of structural engineering in 1943.

Professor Wilbur was responsible for the development of the structural analysis laboratory which was established at the Institute in 1936, and in 1934 he developed and built the simultaneous calculator, a computing machine which solves nine linear simultaneous equations.

Professor Wilbur has had wide experience as a structural engineer and was associated with the firm of Fay, Spofford and Thorndike on the design of the Lake Champlain Bridge, as well as the continuous truss highway bridges over the Cape Cod Canal at Bourne

INCINERATOR PLANTS - EASTERN UNITED STATES

City	Make of Furnace	No. of Furnaces	No. of Cells	Rated Capacity Tons per 24 hrs.	Operating Capacity Tons	Hrs. Daily Operation	No. of Employees	Type of Stoking	Construction Cost		Operating Cost Per Ton Refuse Burned	Type of Incinerator	Preheater	Draft
									Total Plant	Per Ton Capacity				
Atlanta, Ga.	Volund Patent	2	-	170	225	24	27	Auto.	$550,000	$3,235	$0.78	(Stoker Crates (& Rotary Kiln	Yes	(Forced & (Induced
Baltimore, Md.	*P. D. M.	4	16	600	-	24	78	Man.	-	-	-	Multi-Cell	Yes	Forced
" "	Moore	-	-	250	-	Stand-by	-	(Chain (Grate	-	-	-	Multi-Cell	No	Natural
Bridgeport, Conn.	Hiler	-	6	200	75	10	10	Man.	110,000	550	1.47	Multi-Cell	Yes	Forced
Buffalo, N.Y.	Heenan	4	16	500	425	24	78	Man.	750,000	1,500	1.48	Multi-Cell	Yes	Forced
Camden, N.J.	(Decarie (Water-Jacket	2	-	140		-	-	Man.	185,400	1,320	-	(Steel Water- (Jacket-2 Furn.	Yes	Forced
Cedar Rapids, Ia.	Nichols	-	2	150	40	8	4	Man.	120,000	800	0.85	Basket	Yes	-
Columbus, Ohio	Decarie	-	2	140	200	24	22	Man.	118,000	843	1.47	Basket	No	Forced
Cincinnati, Ohio	Superior P.D.M.	-	12	400	150	16	90	Man.	-	-	0.039	Multi-Cell	Yes	Forced
" "	(Bartlett-Snow- (P. D. M.	-	8	200	125	16	10	Man.	-	-	0.085	Multi-Cell	Yes	Forced
" "	(Bartlett-Snow- (P. D. M.	-	8	200	100	8	5	Man.	-	-	0.073	Multi-Cell	Yes	Forced
Dayton, Ohio	Decarie Nichols	-	5	150	80	16	11	Man.	145,000	967	1.36	Basket	Yes	Forced
Decatur, Ga.	Morse-Boulger	-	1	90	40	10	2	Man.	-	-	-	Multi-Cell	No	Natural
Glen Cove, N.Y.	P. D. M.	-	-	100	30	8	3	Man.	170,000	1,700	-	-	Yes	Natural
Greenwich, Conn.	P. D. M.	2	6	150	38	8	7	Man.	158,000	1,053	2.00	Multi-Cell	Yes	Forced
Hackensack, N.J.	P. D. M.	2	-	100	40	10	6	Man.	89,700	897	1.79	Multi-Cell	Yes	Forced
Kenosha, Wisc.	P. D. M.	-	4	120	16	9	4	Man.	111,000	925	2.30	Multi-Cell	Yes	Forced
Lakewood, Ohio	P. D. M.	2	6	150	-	8	5	Man.	104,000	694	1.15	Multi-Cell	Yes	Forced
Larchmont, N.Y.	Morse-Boulger	-	4	120	-	6	3	Man.	100,000	833	-	Multi-Cell	Yes	-
New Bedford, Mass.	Superior	4	12	100	74	8	13	Man.	99,500	995	1.05	Multi-Cell	No	Natural
Newburgh, N.Y.	Hiler	-	3	150	50	8	8	Man.	77,000	513	1.05	Multi-Cell	No	Forced
New Castle, Penn.	Hiler	-	-	100	35	8	4	Man.	40,000	400	-	Multi-Cell	Yes	Forced
Newport News, Va.	Allen	-	4	240	100	10	10	Man.	157,565	657	-	Multi-Cell	Yes	Forced
New Rochelle, N.Y.	Morse-Boulger	2	8	250	54	6	7	Man.	205,000	820	1.05	Multi-Cell	Yes	Forced
Newton, Mass.	Hiler	2	6	60	-	8	6	Man.	178,118	2,968	-	Multi-Cell	Yes	Forced
New York City, N.Y.:														
56th St.	NYC Dept.San	-	4	750	750	24	85	Man.	**1,500,000	2,000	1.05	Multi-Cell	No	Forced
139th St.	Bartlett-Snow	-	4	500	500	24	75	Man.	-	-	1.18	Multi-Cell	Yes	Forced
215th St.	Superior	-	4	750	750	24	96	Man.	-	-	1.02	Multi-Cell	Yes	Forced
73rd St.	Sterling	-	4	500	500	24	75	Man.	-	-	1.65	Multi-Cell	Yes	Forced
Ocean City, N.J.	(Heenan-Froude (Hiler	2	3	75	87	8-10	8	Man.	192,800	2,570	-	Multi-Cell	Yes	Forced
Paterson, N.J.	Hiler	-	8	200	178	16	28	Man.	750,000	3,750	1.38	Multi-Cell	Yes	Forced
Peekskill, N.Y.	Nichols	-	2	90	-	8	4	Man.	94,903	1,053	-	-	Yes	Forced
Pittsburg, Penn.	Koppers	4	4	600	600	24	69	Man.	951,957	1,586	1.30	Multi-Cell	Yes	Forced
Providence, R.I.	Hiler	-	5	160	125	24	46	Man.	***450,000	2,812	2.47	Multi-Cell	Yes	(Forced & (Induced
Rochester, N.Y.	Morse-Boulger	2	6	200	90-100	24	28	Man.	439,000	2,195	3.50	Multi-Cell	Yes	(Forced & (Induced
Schenectady, N.Y.	Hiler	-	6	210	80-110	8-12	10	Man.	165,000	785	1.70	Multi-Cell	Yes	Forced
Toledo, Ohio	Decarie	2	-	100	75	24	15	Man.	175,000	1,750	-	-	Yes	Forced
" "	Sterling	-	4	100	100	24	9	Man.	150,000	1,500	-	-	Yes	Forced
Tonawanda (City) N.Y.	Nichols	-	2	40	7	8	2	Man.	101,531	2,538	-	Basket	Yes	Forced
Toronto, Canada	Sterling	4	16	500	-	16	36	Man.	-	-	-	Multi-Cell	Yes	Forced
Valley Stream, N.Y.	P. D. M.	-	2	80	30	8	6	Man.	55,360	691	3.13	Multi-Cell	No	Forced
Washington, D.C.	Allen	2	6	170	-	6	-	Man.	-	-	-	Multi-Cell	No	Forced
" (O St.)	-	5	15	425	-	24	-	Man.	-	-	-	Multi-Cell	No	Forced
Wilkes-Barre, Penn.	Hiler	-	2	150	-	10	9	Man.	150,000	1,000	-	Multi-Cell	Yes	Forced
Worcester, Mass.	Decarie	-	2	300	180	15	12	Man.	250,000	833	3.00	Basket	Yes	(Forced & (Induced

* P. D. M. = Pittsburg-Des Moines

**Includes steam turbine electric generating equipment

***Includes steam turbine 2300-volt generating equipment.

and Sagamore. He has done important consulting work for various engineering and insurance companies. From 1940 to 1945 he was chief engineer for the Smith-Putnam Wind Turbine project in Vermont for the S. Morgan Smith Company.

During the war he was a consultant to the National Defense Research Committee and was in charge of an investigation dealing with the constructional design of fortifications conducted at the Institute for the Office of Scientific Research and Development.

Dr. Wilbur is a member of the American Society of Civil Engineers and of the Boston Society of Civil Engineers, and has twice received the designers section award of that society. In 1943 the society presented him with the Desmond Fitzgerald award. He is also a fellow of the American Academy of Arts and Sciences, a member of the American Society for Engineering Education, Sigma Xi, and an honorary member of Chi Epsilon, the honorary civil engineering fraternity.

He is the author of many technical papers and bulletins, and with Professor W. M. Fife, of a text book, "Theory of Statically Indeterminate Structures."

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETINGS

Boston Society of Civil Engineers

SEPTEMBER 25, 1946. — A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, Boston, Mass., and was called to order by President George A. Sampson at 7:00 P.M. Ninety members and guests were present and seventy-four persons attended the dinner.

President Sampson announced the death of the following members:

George C. Danforth who was elected a member January 28, 1920 and who died June 30, 1946.

Bertram L. Makepeace who was elected Associate Member October 20, 1915 and who died August 14, 1946.

Albert S. Crane who was elected a member June 20, 1894 and who died August 25, 1946.

Louis C. Lawton who was elected a member March 18, 1896 and who died August 27, 1946.

President Sampson announced that the October meeting will be held Monday, October 28, 1946, which will be Student Night and a Joint Meeting with the American Society of Civil Engineers, Northeastern Section, and Student Chapters. The speakers will be Col. Carroll T. Newton, Corps of Engineers, U. S. Waterways Experiment Station, Vicksburg, Mississippi.

The Secretary announced the election of the following to membership on this date:

Grade of Member: Jack McKee, Richard Halloran,† Edwin E. Corry, John S. Bethel, Jr., Richard C. Dwyer, Charles Y. Hitchcock, Jr., Oscar H. Horovitz, William C. Moberger, Herbert J. Albee,* Robert R. Balmer,* Henry Campbell,* Kenneth M. Cline,* Arnold B. Davis,† Giles L. Evans, Jr.,* Leonard J. A. Fenocketti,* Chesley F. Garland,* Frederick B. Jackson,* Rudolph A. Lofgren,* Arthur F. Mc-

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*Transfer from Grade of Junior.
†Transfer from Grade of Student.

Varish,* Franklin B. Parker,* Henry G. Seeley,* Hyman B. Ullian.*

Grade of Junior: Arthur Hebert,† Gordon H. Searles,† Roy A. Wooldridge.†

Grade of Student: James G. Boulogiane, James M. Rosa, Warren R. Viets.

The President made presentation of the Desmond FitzGerald Medals to members who had been awarded the prizes at the 1945 and 1946 Annual Meeting. At those meetings certificates only were presented and now the medals having become available are now presented to the following:

Scott Keith, member, for his paper on "Hydraulics of the Park River Conduit, Hartford, Conn.", presented at a meeting of the Hydraulics Section held on May 3, 1944, and published in the July, 1944, issue of the JOURNAL.

Prof. Albert G. H. Dietz, member, for his paper on "Details of Design with Timber Connectors", presented at a meeting of the Designers Section held on October 13, 1943, and published in the January, 1945, issue of the JOURNAL.

President Sampson introduced the speaker of the evening, Mr. William N. Nye, Vice-President, Turner Construction Company, New York, who gave a very interesting talk on "Trend of Costs in the Construction Industry". Mr. John Allen, Chief Engineer, U. S. Engineer Office, Boston, Mass., presented data on trends in cost of construction and dredging. Other members of the Society took part in the discussion, including Karl R. Kennison, Stanley M. Dore, Frank L. Flood, Col. Frank M. Gunby, Thomas R. Camp, Channing Howard, Arthur L. Harding and others.

A rising vote of thanks was given the speaker.

Adjourned at 9:00 P.M.

EVERETT N. HUTCHINS, *Secretary*

OCTOBER 28, 1946.—A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, Boston, Mass., and was called to order by President George A. Sampson at 7:30 P.M. Three hundred fifteen members and guests were present and two hundred ninety-nine persons attended the dinner.

This meeting was the Annual Student Night with representatives from the Student Chapters of the American Society of Civil Engineers at Harvard University, Massachusetts Institute of Technology, Tufts, Brown University, Rhode Island State College, Yale University, and of Northeastern University which is also a section of the B.S.C.E. This meeting was also a joint meeting with the Northeastern Section. American Society of Civil Engineers.

The President extended a cordial welcome to the more than 200 students and expressed appreciation of the cooperation of the officers of the student organizations and of the faculty members in making this event so successful.

President Sampson announced that the next meeting of the Society will be held on November 20 at Chipman Hall, Tremont Temple. This to be a joint meeting with the Designers Section, B.S.C.E. Speaker to be Prof. Arthur Casagrande, Associate Professor of Civil Engineering, Harvard University, Cambridge, Mass., who will give a talk on "The Foundations for the New John Hancock Building of Boston".

President Sampson called upon Mr. Harvey B. Kinnison, President of the Northeastern Section, A.S.C.E., to conduct any matters of business required by that Society.

President Sampson called upon Mr. Kinnison to introduce the speaker of the evening, Col. Carroll T. Newton, Corps of Engineers, Director of the U. S. Waterways Experiment Station, Vicksburg, Mississippi, who gave a most interesting talk on "Engineering

Services of the U. S. Waterways Experiment Station with Special Reference to the Mississippi Basin Model". The talk was illustrated with slides.

Adjourned at 9:10 P.M.

EVERETT N. HUTCHINS, *Secretary*

SANITARY SECTION

JUNE 5, 1946.—A meeting of the Sanitary Section was held at the Society Rooms at 7:00 P.M., following an informal dinner gathering at the Ambassador Restaurant. Fifty-two persons attended the meeting, with 42 at the dinner.

The speaker of the evening was Edward L. Winslow, Chief of General Engineering Branch, New England Division, Corps of Engineers, U. S. Army, who gave a most interesting illustrated talk on "Water Supply and Sewage Disposal in Bermuda". In the course of his talk, the speaker requested Scott Keith, of Metcalf & Eddy, to describe the sewage treatment plant for the principal U. S. Army installation in Bermuda.

At the conclusion of his talk, the speaker was accorded a rising vote of thanks and the meeting adjourned about 9:10 P.M.

GEORGE C. HOUSER, *Clerk*

DESIGNERS' SECTION

OCTOBER 9, 1946.—Following the usual dinner at the Ambassador Restaurant, Chairman Dean Peabody, Jr., called the meeting to order at 7:00 P.M., in the Society Rooms at 715 Tremont Temple.

The Clerk's report of the previous meeting on May 8, 1946, was read and approved.

Professor Peabody then introduced Mr. Francis R. MacLeay, Chief Engineer of the Corbetta Construction Co., of New York, as the speaker of the evening. Mr. MacLeay's topic, "The Solution of the Housing Problem" included a discussion of a novel construction method of building a reinforced concrete storage warehouse for the U. S. Navy at Mechanicsburg, Pennsylvania, by using pre-cast units. This discussion was high-lighted by the showing of a sound-color film explaining in detail the complete construction sequence.

Following this film, Mr. MacLeay explained by means of blackboard sketches how this pre-cast method of construction could be applied to building housing units, either single or multi-story units. A lively discussion period followed the talk.

The meeting was adjourned at 9:30 P.M.

Attendance—70 members and guests.

ERNEST L. SPENCER, *Clerk*

HYDRAULICS SECTION

NOVEMBER 6, 1946.—The meeting of the Hydraulic Section was held this evening at the Society Rooms, 715 Tremont Temple, Boston, following an informal dinner at the Ambassador Restaurant.

The meeting was called to order at 7:20 P.M. by Chairman Harold A. Thomas, Jr. After a short business meeting during which the Chairman was empowered to appoint a Nominating Committee, Chairman Thomas introduced the speaker of the evening, Mr. Richard H. Ellis of the Inspection Bureau, Associated Factory Mutual Fire Insurance Co., who gave a talk on "Water Supplies for Industrial Fire Protection".

The talk was followed by an open discussion period with 38 members and guests present.

The meeting adjourned at 8:50 P.M.

J. G. W. THOMAS, *Clerk*

APPLICATIONS FOR MEMBERSHIP

[October 15, 1946]

The By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applicants until the expiration of fifteen (15) days from the date given.

For Admission

Francis T. Bergin, Waltham, Mass. (b. May 26, 1916, Waltham, Mass.) Graduated from Manhattan College in 1938 with B.S. degree. M.S. degree in Civil Engineering, New York University in 1941. Experience: Instructor, Department of Chemistry and Department of Sanitary Engineering, Manhattan College, New York, from June, 1938 to April, 1942; April, 1940 to April, 1942, Junior Sanitary Engineer, Westchester County, New York, Department of Public Works, Division of Sewers; June, 1942 to 1946, served with Sanitary Corps, U. S. Army—Activated and commanded sanitary companies; sanitary inspector, POW camps for 7th Service Command; Activated and commanded Malaria Control Unit in Southwest Pacific, Philippines. Highest rank, Major. From March, 1946 to date with Metropolitan District Water Supply Commission. Refers to *J. F. Cavazzoni, S. M. Dore, L. M. Gentleman, C. J. Ginder.*

Henry E. Bilodeau, Taunton, Mass. (b. June 11, 1913, Taunton, Mass.) Graduated from Taunton High School, 1932; graduate I.C.S., Architectural Engineering, 1936. Experience: February, 1934 to February, 1936, draftsman, surveyman, municipal engineering, Engineering Department, City of Taunton. February, 1936 to May, 1936, employed as Traffic Engineer for City of Taunton, Mass., to work in conjunction with Massachusetts Department of Public Works Traffic Division; May, 1936 to September, 1936, with Mass. Department of Public Works, as Junior Engineer on highway construction; September, 1936 to September, 1938, as Assistant Planning Engineer for City of Taunton, designing and estimating for sewer, water, underground steam and recreational facilities; September, 1938 to August, 1939 with W.P.A. Division of Operation, as Office Engineer (in Fall River and Brockton, Mass.); August, 1939 to November, 1940 as Planning Engineer for City of Taunton; November, 1940 to present for U. S. Engineer Office, Providence, Rhode Island, as Associate Engineer, duties include economic studies, planning and structural and hydraulic designs. 1938 to present doing spare time designing, estimating and surveying for contractors including Land-Court Surveys. Refers to *C. W. Bowen, J. C. Dingwall, H. S. Perdikis, J. B. McAleer, H. B. Shumway.*

Paul S. Crandall, Lexington, Mass. (b December 26, 1919, Lexington, Mass.) Attended public schools in Malden and Lexington and Brown & Nichols School, Cambridge, Mass. Graduated from Massachusetts Institute of Technology in 1942 with B.S. degree in Civil Engineering and received commission of Second Lieutenant, Corps of Engineers, U. S. Army. Immediately called to active service with 401st Engineers (Water Supply) and embarked overseas in October, 1942. Was engaged in the North African campaign (Morocco, Algeria, Tunisia) and then Sicily and Italy. Subsequently took part in the Southern French landing and German invasion with the 7th Army. After the Armistice, was attached to Supreme Hdq. A.E.F. at Versailles and Allied Control Council in Berlin. Returned from overseas October, 1945, on terminal leave and was discharged as Captain, Corps of Engineers in February, 1946. Entered employ of Crandall Dry Dock Engineers, Cambridge, Mass., on November 13, 1945, as draughtsman. Since October, 1946, assistant engineer for same company in Dordrecht, Holland, on the installation of a railway dry dock. Refers to *J. B. Babcock, J. S. Crandall, R. H. Lindgren, E. Mirabelli, C. H. Norris.*

HAROLD J. DUFFY, West Roxbury, Mass. (b. November 27, 1895, Roxbury, Mass.) 1908-1912, Mechanic Arts High School; 1916-1917, Lowell Institute, Building Course, Massachusetts University extension courses; Lectures and Home study, Strength of Materials, Concrete Testing Structural Design; Estimating; 1914-1915, Franklin Union, Architectural drawing, concrete design. Experiences, 1912-1921 (except 1 year in Army) with Stone & Webster, Boston, Watertown, Pawtucket, R. I., Padocol, Ky., blueprinter, rodman, transitman, inspector, purchasing agent, resident engineer on building construction, foundry, machine tool installation, power station buildings, oil storage tanks, turbo-generator units, boilers, condensing equipment, etc. 1921-1929; Boston Elevated Railway, Boston, assistant engineer, trackwork, design and field layout, rapid transit development studies, subways, elevated, station and yard layouts; 1929 to date Commission of Massachusetts Division of Metropolitan Planning and State Planning Board, assistant engineer, senior engineer, transportation planning, highway and rapid transit development, studies, estimates, reports, legislation. Refers to *A. W. Dean, A. B. Edwards, L. E. Moore, L. H. Smith, A. D. Weston.*

OTIS D. FELLOWS, Newton Centre, Mass. (b. July 23, 1881, Boston, Mass.) 1896-1900, Newton High School; 1900-1904, Massachusetts Institute of Technology, Mining Engineering Course. 1904-1905, R.R. engineering and Copper smelter construction in Houghton, Michigan; 1905-1911, Mining Engineer with the Copper Range Co., Trimountain, Michigan, in charge of surface and underground surveying, shaft-sinking, general construction, etc.; 1911-1926, Stamp Mill Superintendent in charge of plant, Construction and Mechanical Engineer, steam power and turbo-electric installations, conveyor systems, metallurgical operations, water supply and highway and bridge construction. This was very general engineering experience covering almost every branch of engineering, and design of wooden, steel and concrete structures; 1926, returned to Boston; 1926-1928, Department of Public Works-Highways; 1928-1940, Division of Metropolitan Planning, first as assistant engineer then as acting Chief Engineer. This was on Planning work, especially with reference to transportation, highways, parkways, rapid transit, traffic, etc. Traffic studies and plans for intersection improvements etc. 1940—Chief Planning Engineer of the Massachusetts State Planning Board. In charge of technical staff and activities relating to Land Use, Water Resources, Power, Air Ports and Airport Planning, transportation, recreation, industry, etc. At present—Chief Planning Engineer, Massachusetts State Planning Board. Refers to *A. W. Dean, A. B. Edwards, L. E. Moore, R. K. Hale. L. H. Smith.*

EDWIN J. FITZGERALD, Medford, Mass. (b. November 17, 1899, Lexington, Mass.) Attended Franklin Union 1919 - 1921; Northeastern University

1921-1923; Lowell Institute 1924-1925. Experience: August, 1919 - 1922 employed as transitman by Ernest W. Branch, Civil Engineer of Quincy; 1922-1924, transitman for Dana F. Perkins, Civil Engineer, Medford, Mass.; 1924-1926, Chief of Survey Party with F. A. Barbour; 1926-1928 Dept. of Public Works, Grade II; 1928-1929 Survey Chief with Fred Perkins, Scituate, Mass.; 1930-1931 Boston and Maine Railroad, survey work and draftsman; 1931-1936 self employed as engineer and contractor, Medford, Mass.; 1936-1938, Geodetic Survey, Medford, Mass., as Senior Engineer; 1938-1939 Dept. of Public Works, Chief of Survey; 1940-1941, F. A. Barbour, engineer in charge of road layout (Camp Devens); 1941-1943, Sawyer & Barletta, contractor, Park Square Building, Boston, chief engineer charge of construction, South Weymouth Air Base; 1943-1945, U.S.E.D., Park Square Building, Boston, Civil Engineer, S.P. 8; 1945-1946, Jackson & Moreland, engineer; at present with C. J. Maney as cost engineer. Refers to *F. A. Barbour, W. A. Ford, J. Guertin, R. Marble.*

GEORGE B. GARRETT, JR., Boston, Mass. (b. October 24, 1921, Cleveland, Ohio). Received B.S. degree in Sanitary Engineering from Case School of Applied Science and did graduate work in the same field at Michigan State College. Case School of Applied Science, September, 1940 to June, 1942; July, 1944 to April, 1945; Michigan State, September, 1945 to June, 1946. Have been employed as a junior chemist for the city of Cleveland at the Easterly Sewage Treatment Works, July, 1942 to June, 1944. During my senior year at Case and eight months thereafter was employed by the school as a research assistant. At present employed as chemist by Metcalf & Eddy. Refers to *H. B. Allen, S. E. Coburn, E. S. Chase, F. L. Flood, A. J. Burdoin.*

MYLE J. HOLLEY, JR., Brighton, Mass. (b. February 7, 1917, New York, N. Y.) Graduated from Peekskill High School, Peekskill, New York, in 1935, entered Massachusetts Institute of Technology in the same year and, in 1939 received B.S. degree in Civil Engineering. Experience: September, 1939, to June, 1941, was Assistant in the Department of Civil Engineering at Massachusetts Institute of Technology. During this period in addition to staff duties studied graduate subjects, majoring in Structures. Also a stress-analyst on the Smith-Putnam Wind Turbine Project under the direction of Dr. John B. Wilbur, Chief Engineer of the Project; 1941, accepted a position with the S. Morgan Smith Company of York, Penna.; 1941, to 1945, served successively, as Test Engineer and Stress Analyst on the Smith-Putnam Turbine Project, and as Assistant Chief Engineer of the Wind Turbine Division of the S. Morgan Smith Company; in 1945 the Wind-Turbine Division was de-activated and from 1945 to 1946, was employed by the S. Morgan Smith Company as a Stress and Vibration Analyst; June, 1946 to date Instructor in Civil Engineering at Massachusetts Institute of Technology. Refers to *J. B. Babcock, W. M. Fife, E. Mirabelli, J. B. Wilbur.*

CHARLES T. MAIN, 2nd, Winchester, Mass. (b. April 16, 1915, Great Falls, Montana). Graduated from Dartmouth College in 1938, A. B. degree in Civil Engineering. Experience, February, 1939 to June, 1942, with the Kendall Company. First at their New Beford, Mass., plant where I served a year's apprenticeship covering all the departments of the mill. Then spent six months on various engineering assignments in connection with the operation and liquidation of this cotton mill. Transferred September, 1940 to Pelzer Mills (subsidiary of the Kendall Company) Pelzer, South Carolina, where principal work was in connection with extensive rehabilitation of the plants. In charge, for one year, of rearranging much of the productive machinery which involved the making of detailed floor layouts and problems of power transmission, lighting, and humidifying. Other work included a detailed report on the humidifying and air conditioning system, instructing personnel in the system's operation, and assisting in a survey of additional substation capacity. June, 1942, joined U. S. Coast Guard Reserve and assigned to Charleston, S. C. Positions held included Base Engineer, District Chemical Warfare Officer, and District Property Officer. June, 1944, assigned to District Office, Ketchikan, Alaska. Served as District Electrical Engineer for 16 months. Highest rank Lieutenant. Released from active duty February, 1946. At present employed by Chas. T. Main, Inc., February, 1946 to date as a Mechanical Engineer on Textile Mill design and valuation. Refers to *A. W. Benoit, F. M. Gunby, B. O. McCoy, T. H. Safford, W. F. Uhl.*

Edward R. Marden, Brookline, Mass. (b. September 22, 1918, Winthrop, Mass.) Graduated from Massachusetts Institute of Technology in 1941 with B.S. degree in Building Engineering and Construction. Experience: have worked with my father's construction company; entered Army and had positions as assistant area engineer and post engineer with the Corps of Engineers. Both in the United States and Overseas. Had charge of Airport construction (Hangars and Runways), permanent type barracks, mess-halls, pumping stations, etc. At times had 2000 civilian construction men under my supervision, usually about 1000 men. On return from overseas duty, was placed in charge of construction and maintenance at the Boston Port of Embarkation. Was released from active duty February, 1946. At present am employed as Assistant Superintendent on a Veteran's Housing Project, building 100 houses. Refers to *M. J. Cullity, J. J. Casey, D. Peabody, Jr., W. C. Voss.*

Transfer from Grade of Junior

John L. Bean, Ayer, Mass. (b. July 17, 1916, Ayer, Mass.) Graduated from Northeastern University in 1940, receiving B.S. degree in Civil Engineering, and was employed until March 1941, by the Packard Dredging Company as timekeeper. March, 1941, was drafted into the Army as a private. March, 1942, was accepted at the Engineer's OCS at Ft. Belvoir, Va., where I received a commission as a Second Lieutenant. After leaving Ft. Belvoir I was assigned to a Maintenance of Way Company in a Railway Operating Battalion and stayed with that unit until I was released from the service in November, 1945, as a Captain, Company Commander of a Maintenance of Way Company. Since March of 1946 I have been employed by the Town of Ayer taking over the duties of the Superintendents of the Sewer and Water Department. Refers to *C. O. Baird, E. B. Cobb, A. E. Everett, E. A. Gramstorff.*

Donald J. Fogarty, Mattapan, Mass. (b. October 24, 1917, Saugus, Mass.) Graduated from Tufts College in 1941, with B.S. degree in Civil Engineering. Experience: August, 1941 to date, junior and assistant hydraulic engineer with U. S. Geological Survey, except May, 1945 to March, 1946 when I was in U. S. Naval Reserve. Engineering duties consisted of obtaining stream flow data in the field, and computing and compiling stream flow records in the office. Refers to *W. S. Daniels, H. B. Kinnison, C. H. Minehan, G. K. Wood.*

Francis H. Ledgard, Lowell, Mass. (b. August 31, 1910, Maynard, Mass.) Graduated from Northeastern University in 1932, B.S. degree in Civil Engineering. Special courses at Massachusetts Institute of Technology, 1932-1940. Held teaching, engineering, auditing, surveying and drafting positions. 1940-1945, War Department, U. S. Army Engineers at office of the Post Engineer, Fort Devens, Mass., employed as Civil Engineer. Since June, 1945 to date established own engineering and land surveying business. Type of work undertaken includes subdivisions, design of buildings, layout of plants, and land surveying. Refers to *C. S. Ell, A. E. Everett, E. A. Gramstorff, W. A. Raphael.*

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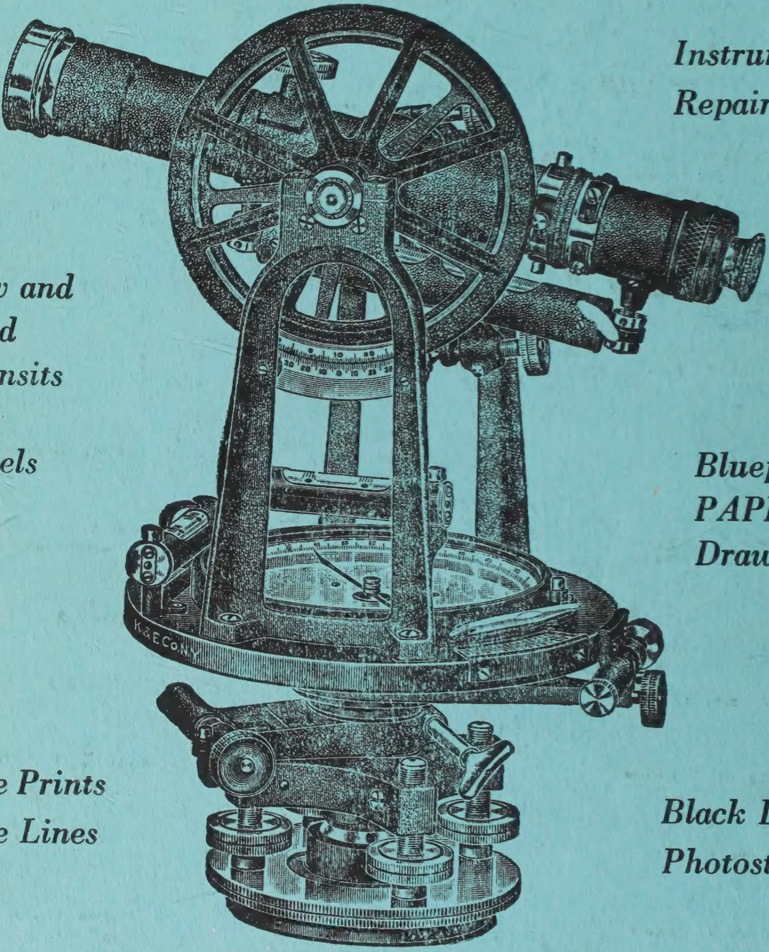

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